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SPECIFICATION

OF

SAMUEL HALL,

BOILERS, FURNACES, AND FLUES.

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Boilers, Furnaces, and Flues.

HALL'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, SAMUEL HALL, of King's Arms Yard, in the City of London, Civil Engineer, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her
5 Royal Letters Patent, under the Great Seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster, the Nineteenth day of March One thousand eight hundred and forty-nine, in the twelfth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Samuel Hall, my exors, admors, and assigns, Her especial licence, full power,
10 sole privilege and authority, that I, the said Samuel Hall, my exors, admors, and assigns, and such others as I, the said Samuel Hall, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town
15 of Berwick-upon-Tweed, my Invention of "IMPROVEMENTS IN APPARATUS FOR EFFECTING THE COMBUSTION OF FUEL AND CONSUMING SMOKE, AND FOR PREVENTING EXPLOSIONS OF STEAM BOILERS, AND OTHER ACCIDENTS TO WHICH THEY ARE LIABLE," in which said Letters Patent is contained a proviso, that I, the said Samuel Hall, should cause a particular description of the nature of my said Invention,
20 and in what manner the same is to be performed, by an instrument in writing under my hand and seal, to be inrolled in Her said Majesty's High Court of

Hall's Improvements in Boilers, Furnaces, Flues, &c.

Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said Samuel Hall, do hereby declare that the nature of the said Invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statement thereof, reference being had to the Drawings hereunto annexed, and to the figures and letters marked thereon, the same letters referring to the same parts in each figure on each Sheet respectively (that is to say):

I shall now state the objects and nature of my several improvements in the order in which they are mentioned in the said Letters Patent.

Firstly, the object and nature of my "Improvements in Apparatus for Effecting the Combustion of Fuel and Consuming Smoke," are the making of furnaces more perfect for effecting those processes, the rendering of them as well as the boilers to which they may be applied more durable, the economizing of fuel, and the reducing of the manual labor required in working them, being improvements upon that part of my Patent of the Twentieth day of February, One thousand eight hundred and forty-five, relating to "Improvements in Boilers, Furnaces, and Flues in Consuming Fuel and Preventing Smoke."

Secondly, the objects and nature of my "Improvements for Preventing Explosions of Steam Boilers, and other Accidents to which they are liable," are the preventing of the water from becoming too low in such boilers, owing to the uncertain action of force pumps or other modes of supplying them with water, the preventing of the water from becoming too low in such boilers, whether by leakages or other causes, while the force pumps or other apparatus for supplying them with water are at rest, as at meal times, &c., and the causing of the safety valves to act with unerring certainty by preventing their becoming staked or fastened down on their seats by accidental causes, or from being overloaded by being left to the discretion of firemen or other persons.

Having stated the objects and nature of my improvements, I will now describe the apparatuses in the same order as that in which they are herein-before enumerated, beginning therefore first with my "Improvements in Apparatus for Effecting the Combustion of Fuel and Consuming Smoke."

Figures 1, 2, and 3, Sheet I, shew two boilers, to which my said improvements are applied. A and A^x are those boilers; B and B^x, the furnaces; C and C^x, the ash pits; and D and D^x, the hoppers for receiving the supply of fuel; E and E^x, F and F^x, and G and G^x, are three plates which form the backs of the hoppers, between which there are two spaces for supplying thin

Hall's Improvements in Boilers, Furnaces, Flues, &c.

streams or sheets of air, as shewn by arrows, into the fronts of the furnaces to effect the consumption of smoke and inflammable gases as they arise from the fuel. This mode of supplying the air is attended with two advantages, videlicet, it preserves the plates in front of the furnaces from becoming (as
5 they otherwise would do) too hot, and in doing so the air acquires a considerable increase of temperature which predisposes it the more rapidly to combine with and the more accurately to consume such smoke and gases. The minimum quantity of air required for that process is obtained by the regulating plates a and a^x , which must be so much opened as to admit precisely as much air as
10 is necessary to prevent the slightest appearance of smoke from the top of the chimney and no more. The air may be heated to a considerable extent previously to its passing between these three plates by means of a number of pipes placed in the chimney or in a chamber in the flue leading thereto from the furnace. A, Figure 4, is a portion of a boiler; B is the chimney; c, c, c ,
15 a flue to convey the heated gases to the chimney after having passed from the furnace under and around the boiler; d, d , are cast iron or other pipes fixed in the flue c, c , on the outsides of which pipes the heated gases pass on their way to the chimney; e is a passage for atmospheric air to pass through the insides of the pipes; and f, f , is a channel to convey the air which is heated
20 by passing through them to the front of the fire-place to enter through or between the plates above mentioned into the furnace; H and H^x are plates to form the fronts of the hoppers fixed on axles b and b^x , which may be raised or lowered at pleasure, and kept in any desired position by a pin put underneath them in one of the holes f, f, f, f , and f^x, f^x, f^x, f^x , in the hopper sides.
25 I and I^x are two series of as many fire-bars as the widths of the furnaces will admit; they are to be moved to and fro, as hereafter explained, by eccentrics (two of which are shewn by J and J^x) placed on the revolving shafts K and K^x . The ends or necks of the shafts, which are round, are supported by carriages placed on brackets, two of the latter being shewn by d and d^x . The excentrics
30 revolve within the forks e and e^x of the fire-bars, and thereby effect the above-mentioned backward and forward movements of such bars. c, c , and c^x, c^x , are projections on these bars in the form of inclined planes rising from them, and cut in front at right angles with them. g, g, g , and g^x, g^x, g^x , are projections on the sides of the fire-bars to keep them at proper distances asunder.
35 L, L, and L^x, L^x , are bearers put across the ash pit for carrying them. M and M^x are moveable shelves covered with fire brick, the widths of the furnaces respectively, and the ash pits extend underneath these shelves to receive the clinkers or scoria, and any other matters which may be discharged from the furnaces. h and h^x are levers attached to the shelves; and i and i^x

Hall's Improvements in Boilers, Furnaces, Flues, &c.

are rods applied to the levers to move the shelves from the horizontal to the vertical position, as shewn by dotted lines, to discharge the clinkers on them into the ash pits. N, Figures 1 and 5, is an iron case, shewn in plan at Figure 1^x, through which a stream of water is passed, which I call a boiler protector. *o* is a pipe to connect one end of the protector with the feed pump 5 or other apparatus for supplying water to the boiler. *p* is another pipe to connect the other end of the protector with the boiler near the bottom; the stream of water passes through the above in the direction of the arrows, and the plate *s* makes the stream rush with rapidity at the bottom of the protector, although from its not fitting closely it allows the water to find its proper level 10 above the plate in the protector. *q, q,* are small pipes at the highest corners of the protector to connect it with the boiler above the water line. *r, r, r, r,* are cement joints to attach the cast-iron ends to the protector, which are bolted together with bolts. The water may be passed through the protector from the feed pump or other apparatus for supplying the boiler with water, as here 15 shewn, or it may be taken from one side of the boiler and passed through the protector to the other side thereof, or a stream of water may be passed through it to be heated for supplying bleachers, dyers, and other pans or vessels, or for any other useful purposes, the object of this case or vessel being to absorb the heat of the fire as it is generated on the fronts of the fire-bars instead of its 20 being allowed to accumulate and rush when so accumulated to the front part of the boiler, as is the case when arches of fire bricks range over the fire in the situation of this protector; but the following plates of fire bricks or other suitable material, *V* and *V^x,* may be affixed to or at a small distance from the bottom of the protector N, or on the inclined portion of the front of the boiler *A^x,* to 25 reflect the heat of the fire upon the fresh coal on its entrance from the hopper into the furnace for the purpose of igniting it. I also apply similar plates to or at a small distance from the tops and sides of such furnaces as are situated within boilers. *j, j,* and *j^x, j^x,* are plates placed in an inclined position in the fronts of the furnaces for the double purpose of catching the small particles of 30 coal which may drop between the fire-bars in the fronts of the furnaces, and of checking the supply of air to the furnaces, and preventing its rushing at once to the far ends of the ash pits without passing sufficiently through the front ends of the fire-bars for the ignition of the coal [as it enters the furnaces. These plates are fixed on axles, and may be lifted up in front when it is 35 necessary to get access to the ash pits to withdraw the ashes, or for any other purpose. *k* and *k^x* are plates, fixed also on axles at the back ends of the fire-bars for the purpose of regulating the quantity of air passing through those parts of the furnaces, and for stopping its passage altogether, or as nearly so as

Hall's Improvements in Boilers, Furnaces, Flues, &c.

possible when the furnaces are at rest. This is done by the rods l and l^x , and levers m and m^x , which are attached to them. n and n^x are plates placed over the fronts of the ash pits. U, Figures 2 and 3, is an internal longitudinal flue (of which there may be more than one) to receive the flame or heated gases after they have passed underneath the boiler from the furnace; and U^1 is a cross flue branching from it right and left near the front of the boiler to convey such flame or heated gases to two external side flues extending from the front of the boiler to the chimney.

The operations of these furnaces are as follows:—When the excentrics are put in motion by the revolving of the shafts, the fire-bars are made to move backward and forward as before stated, and the fuel which is put into the hoppers is supplied to and distributed over the whole length of the furnaces by the bars, the right-angled ends of the projections upon them pushing the fuel into the furnaces when moving in the direction towards the fire bridges, and their inclined planes sliding under it on their return without moving it in a backward direction. The quantity of coal required to be supplied is regulated by the speed of the excentrics, one revolution of them, and of course one stroke of the fire-bars, in about three minutes being in most cases found to supply sufficient. The coal, or the coke into which it is converted, is burnt in its passage over the fire-bars, and the incombustible matters are dropped into the ash pits by occasionally moving the shelves from the horizontal to the vertical position.

Figure 2, Sheet 1, shews also an apparatus which is fixed on the boiler A^x , for regulating the generation of steam, and preventing the waste of fuel. O is a box, furnished with two valves P and Q, which is attached by the branch pipe R to such boiler. This box has a short pipe S on one side of it, having a cock T attached to it, to which another pipe S^1 is applied to connect the box O with the ash pit. The valve P should be weighted according to the pressure at which the boiler is required to work, and the valve Q should only have a little weight upon it, viz^t, as much as is sufficient to cause the steam to descend into the ash pit when the cock T is open. The usual method of checking the generation of steam when it is too high and escaping at the safety valves is to open the fire doors, thereby producing two bad effects, viz^t, the cooling of the furnaces, boilers, and flues, by the admission of cold air, thereby injuring them, particularly the boilers, and causing a great waste of fuel as the furnaces, boilers, and flues, must be again heated when the steam is becoming too low and requires increasing. This is not the case with the use of my above-mentioned improved apparatus, the action of which is as follows:—When the steam is so high that it would escape into the atmo-

Hall's Improvements in Boilers, Furnaces, Flues, &c.

sphere through the usual safety valve, weighted say the same as valve P, it is prevented so doing by the valve Q, and caused to descend into the ash pit, where it reduces the quantity of steam generated by decreasing the supply of air passed through the fire bars, that being done by substituting the waste steam into the ash pit in lieu of air in quantities proportioned to the surplus 5 of steam generated.

I will now proceed to describe the different members of my "Improvements in Apparatus for Preventing Explosions of Steam Boilers and other Accidents to which they are liable," in the same order as I have stated the causes from which they arise. 10

My first improvement for effecting the above purpose consists in the supplying of boilers with water (and at the same time measuring it) in an unerring manner, which is not the case with the usual pumps or other feeding apparatus. The apparatuses for effecting this part of my improvements are of two kinds; the first operates by the opening and shutting of cocks, and the 15 other performs the same operation by the opening and shutting of valves. The first-mentioned apparatus is shewn by the accompanying Drawing, Figure 1, Sheet 2, which is partly in section and partly otherwise. A, A, is the top of a steam boiler. B is a cylindrical vessel to be alternately filled with water and emptied into the boiler in a manner hereafter to be described; 20 and C and D are two double-way cocks attached to it by flanches, for effecting that process. E is a pipe with two passages *a* and *b*, which connect the vessel B by means of cock D with the boiler; the pipe or passage *a* connects that vessel and the boiler at their bottoms, and the passage *b* and pipe *c* connect them at their tops. F is another pipe, which by means of cock C and pipe *d*, 25 connects the bottoms of vessel B and cistern G, pipe *e* at the same time connecting the top of vessel B with the atmosphere. H and I, Figures 1 and 2, are two spur wheels keyed upon the spindles of the cocks C and D, and J is another wheel keyed on shaft *f*; it has a proper number of teeth placed in the required situations for working into the other wheels for shut- 30 ting and opening the cocks alternately, as will be hereafter explained. K is a bevel wheel keyed also on the shaft *f*, and L is another bevel wheel working into it, being keyed upon the vertical shaft *g*; this is turned round by the shaft *h*, by means of the cones *i* and *j*, and the belt *k*. The whole is put in motion by the pulley *l* and belt *m*, the latter being moved by any suitable means. 35

The following is the operation of the above-described apparatus:—The cistern G is to be constantly kept full of water by any convenient means for the supply of water to the boiler by means of the vessel B, which supply is effected in the following manner:—When the pulley *m* is put in motion it

Hall's Improvements in Boilers, Furnaces, Flues, &c.

causes the wheel J to revolve in the direction shewn by the arrow upon it, and the teeth *n, n,* and *o, o,* act upon the two spur wheels H and I, which also revolve in the directions shewn by the arrows on them, and thereby shut and open the two cocks C and D alternately. The Drawing shews the cock

5 C just closed. The teeth *n, n, n,* having just acted upon the wheel H, (the vessel B being now full of water,) the teeth *o, o, o,* act upon the wheel I and open the cock D, whereby the water is allowed to descend in the boiler by its superior specific gravity over that of steam (which is admitted above it by pipe *c*); the teeth *o, o, o,* are followed by teeth *n, n, n,* which shut the

10 cock D, and when that is done the teeth *o, o, o,* open the cock C, and allow the vessel B to be again filled with water through pipe F from cistern G; the teeth *n, n, n,* then shut the cock C, and come again to their situation as shewn in the Drawing ready for repeating the above operation. It is obvious that by this routine of opening and shutting the two

15 cocks an uniform and certain supply of water to steam boilers will be effected, and that such will be the case no matter how great the pressure at which they are worked, for it is evident that by means of the pipe *c* the pressure at the top of the vessel B will be as great as in the boiler, and that the water will descend as above mentioned from the former to the latter by

20 the superiority of its specific gravity over that of steam. The supply of the requisite quantity of water to the boiler is regulated by the float *p*; it is counterbalanced by the weight *q* by means of the lever *r* and the rod *s*, the slot therein *t* in the latter inclosing the belt *k*, which raises and lowers it on the cones *i* and *j* exactly as the float rises and falls. The line *u* shews the proper

25 height of the water in the boiler, and it is obvious that if the water lowers in it the float will descend, and cause the belt *k* to do the same, and thereby drive the apparatus quicker, and increase the supply of the water, and that in the event of the water rising above the water line the float will also rise and perform the reverse operation, and thereby reduce such supply.

30 The second apparatus for supplying water to boilers by valves is similar to that described as furnished with cocks, and is shewn by Drawing, Figure 1, Sheet 3. A, A, being the top of a steam boiler; B, a cylindrical vessel to be alternately filled with water, and emptied into the boiler as already described to be done by cocks; C, C, and D, D, are two pairs of valves to

35 answer the same purpose as the two double-way cocks as before shewn by the same letters in Sheet 2; *a, a,* and *b, b,* are two pipes to connect and disconnect the boiler and vessel B, by the opening and shutting of the latter pair of valves; and *c, c,* and *d, d,* are two other pipes, the former to connect and

Hall's Improvements in Boilers, Furnaces, Flues, &c.

disconnect the vessel B and cistern G, and the latter to do the same with vessel B and the atmosphere.

The operation of this apparatus is the same as that already described with double-way cocks. To perform which wheels similar to those shewn by H and I, Sheet 2, as put on the cocks, must be put on the shafts on which the 5 excentrics M, M, are fixed, and an intermediate wheel like that shewn by J, Sheet 2, with the proper number of teeth in the situations required, must work in them, by which means the two pairs of valves C, C, and D, D, will be opened and shut respectively, in the same way as is performed by the two double-way cocks; any other mode, however, may be adopted to open and shut 10 each pair of valves alternately.

Figure 1, Sheet 4, is an apparatus for supplying water to boilers when it is too low in them, when no water is being supplied to them, as at meal times, &c. A, A, is the top of the boiler; B, B, is the bottom of it; C, C, is the water line, or height at which the water ought to be in the boiler; D is a float, 15 of stone or other material, to regulate the height of the water in the manner hereafter described; E is a cistern supplied by water through pipe *a* and valve *b* by any convenient means; F, G, are two pipes furnished with valves *c* and *d*, properly weighted to overcome the pressure of the steam in the boiler, to connect the cistern with the boiler, and to disconnect them, as hereafter 20 pointed out; F opens into the top of the cistern and into the top of the boiler, which are connected and disconnected as required by the valve *c*; G, opens into the bottoms of such cisterns and boiler, and they are in the same way connected and disconnected by valve *d*; *e* is a valve which when shut, as herein-after mentioned, renders the water cistern E a close vessel; *f* is a rod 25 of iron on which float D is suspended, and which is counterbalanced by lever *g*, and the weight on its other end *h*, acting on the pin *i*, which (when the water in the boiler becomes too low) allows the collar on the rod *f* to descend through a hole in lever *k*, and deposit the spherical weight *o* upon it, and thereby close the valve *e*. When that is done the float D on still further descending 30 opens valves *c* and *d* by the pin *t* in the rod *f* pressing upon levers *m* and *n*, both of which reach to that pin, thus supplying the boiler with water till it becomes of the proper height, when the rising of the float prevents any further supply by closing the valves *c* and *d*, and opening the valve *e*.

The operation of this apparatus is as follows:—When the water in the 35 boiler becomes too low the float D descends, and by means of the rod *f* lowers the spherical weight *j*, as above stated, upon the lever *k*, which shuts the valve *e*, and by means of the pin *t*, acting upon the levers *m* and *n*, opens

Hall's Improvements in Boilers, Furnaces, Flues, &c.

the valves *c* and *d*, which allow water to descend from cistern *E* into the boiler.

The above apparatus is calculated to prevent the water becoming too low in either high or low pressure boilers, but in low pressure boilers that may be
 5 done by the following still more simple apparatus, as shewn by Figure 2 :—*E* in this Figure is a cistern open to the atmosphere, similar to that shewn by the same letter in Figure 1, and it is placed so high that the column of water is superior in pressure to that of the steam in the boiler, so that when the water therein becomes from any cause too low, float *D* descends and opens
 10 valve *d* by means of the rod *l* and lever *n*, and allows the water to descend from cistern *E* to the boiler till it attains the proper height therein, and thereby raises float *D*, which closes valve *d*, and stops any further supply of water to the boiler.

My third improvement consists in certain apparatus for securing the un-
 15 erring action of safety valves, and preventing such explosions or accidents from taking place as are owing to the valves not acting freely or being overweighted ; this apparatus is shewn in Figure 2, Sheet 3. *M* is a safety valve on the boiler opening upwards, to prevent the pressure of the steam therein becoming too high, and thereby causing them to burst or explode. *N* is another safety
 20 valve opening downwards, to prevent boilers collapsing by a vacuum being accidentally formed within them ; the valve *M* is fixed on a vertical spindle *v*, on which a spur wheel *O* is staked for turning it round ; the valve *N* is also fixed on a vertical spindle *w*, with a spur wheel *P* staked upon it for the same purpose ; there is a deep spur wheel or pinion *Q* staked on a spindle *x, x*, into
 25 which these two spur wheels work, allowing the one to rise and the other to fall for opening the safety valves upwards and downwards respectively. A worm wheel *R* is staked on the spindle *x, x*, and a worm *S* fixed on the shaft *f, f* ; the worm works into the wheel, whereby it is obvious that the valves *M* and *N* will, by any suitable means be turned very slowly round, and
 30 thereby fit very accurately on their seats, without the possibility of their adhesion together by any cause. The proper pressure downwards on the safety valve *M* is regulated by the weights 1, 2, & 3, in addition to the weight of the spindle *v* and of the spur wheel *O*, and the pressure on the other safety valve *N* upwards is regulated by the weight of the ball *a*¹ and the lever *b*¹
 35 bearing upon the projection *c*¹ on the spindle *w* ; all the weights and levers on these valves are boxed up in the chamber formed by a casing attached to the frame *z, z, z*, so that no person can have access to them to alter the pressure of either of them.

Hall's Improvements in Boilers, Furnaces, Flues, &c.

Having fully described the objects and nature of my Inventions, and the apparatus and machinery for putting them into operation, I will now proceed to state the extent of my claims, beginning with those relating to my improvements in apparatus for effecting the combustion of fuel and consuming smoke, which are, as I have already stated, improvements upon that part of my Patent of Twentieth of February, One thousand eight hundred and forty-five, relating to "Improvements in Boilers, Furnaces, and Flues in Consuming Fuel and Preventing Smoke."

My first claim under this head is the boiler protector, shewn by N, Figures 1 and 5, Sheet 1. My claim to this protector are as follow:—I claim it, firstly, when water is passed through it to the boiler from the feed pump or other apparatus used for supplying the boiler with water, as herein shewn.

Secondly, when water is passed through it from the well or other source of supply to the feeding cistern, preparatory to its being passed from thence to the boiler in the usual way.

Thirdly, when water is taken from one part of the boiler and passed through it to any other part of the boiler.

Fourthly, when water is passed through it for supplying dye pans, bleaching pans, &c. with warm water, or for any other useful purposes.

My second claim is for boilers with bottoms of an inclined shape from their fronts, as shewn by A^x, Figure 2, Sheet 1, so as to answer the same purpose as the boiler protector N, Figures 1 and 5 of that Sheet, and having a cross flue in and near the front of the boiler, either branching right and left into the external side flues from a central longitudinal flue, as shewn in the Drawing, or simply connecting one external side flue with the other, being for the purpose of superseding the necessity of having an external flue in front of the boiler.

My third claim is for plates, of fire brick or other proper material, placed underneath the boiler protector or fronts of boilers for the purposes herein-before mentioned, as well as at the sides and tops of such furnaces as are situated within the boiler for the same purpose.

My fourth claim is for the inclined plates *j, j*, and *j^x, j^x*, Figures 1 and 2, Sheet 1, for the purposes herein-before mentioned.

My fifth claim is for the plate *k, k*, shewn also by the last-mentioned Figures and Sheet.

My sixth claim is for the clinker shelf lined with fire brick M, as shewn also in the last-mentioned two Figures and Sheet, for the purpose of receiving the clinkers or scoria from the fire-bars, and letting them drop occasionally

FIG. 3.

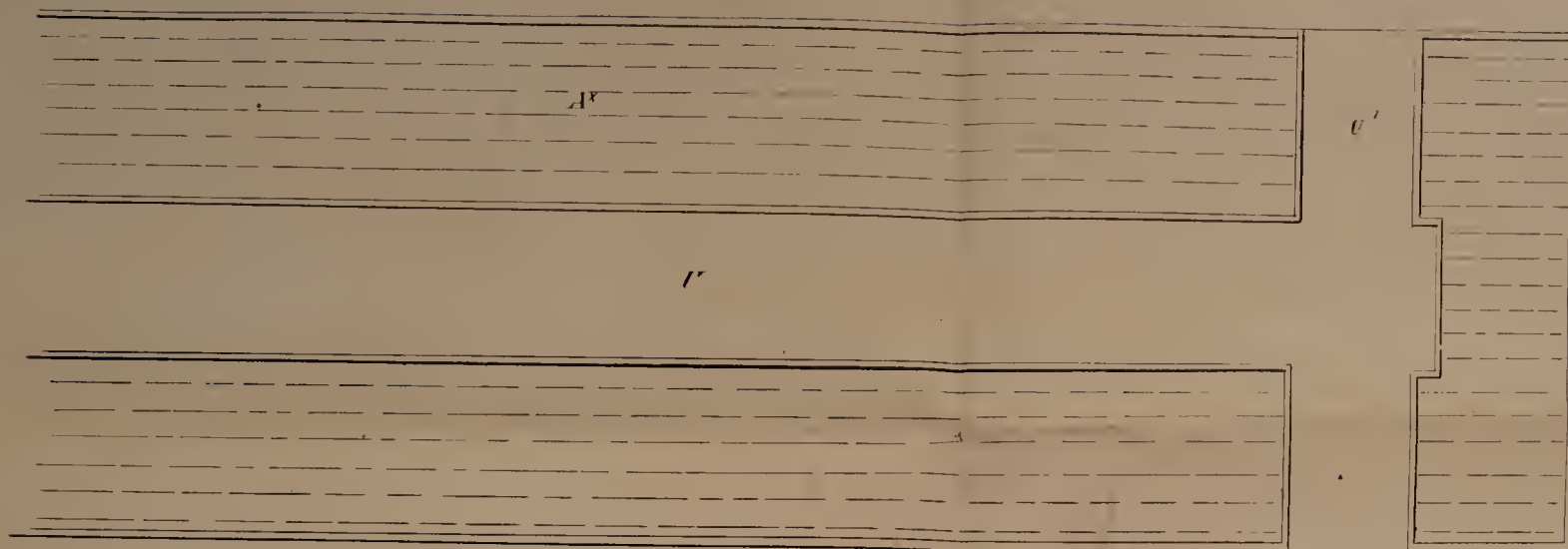


FIG. 1.

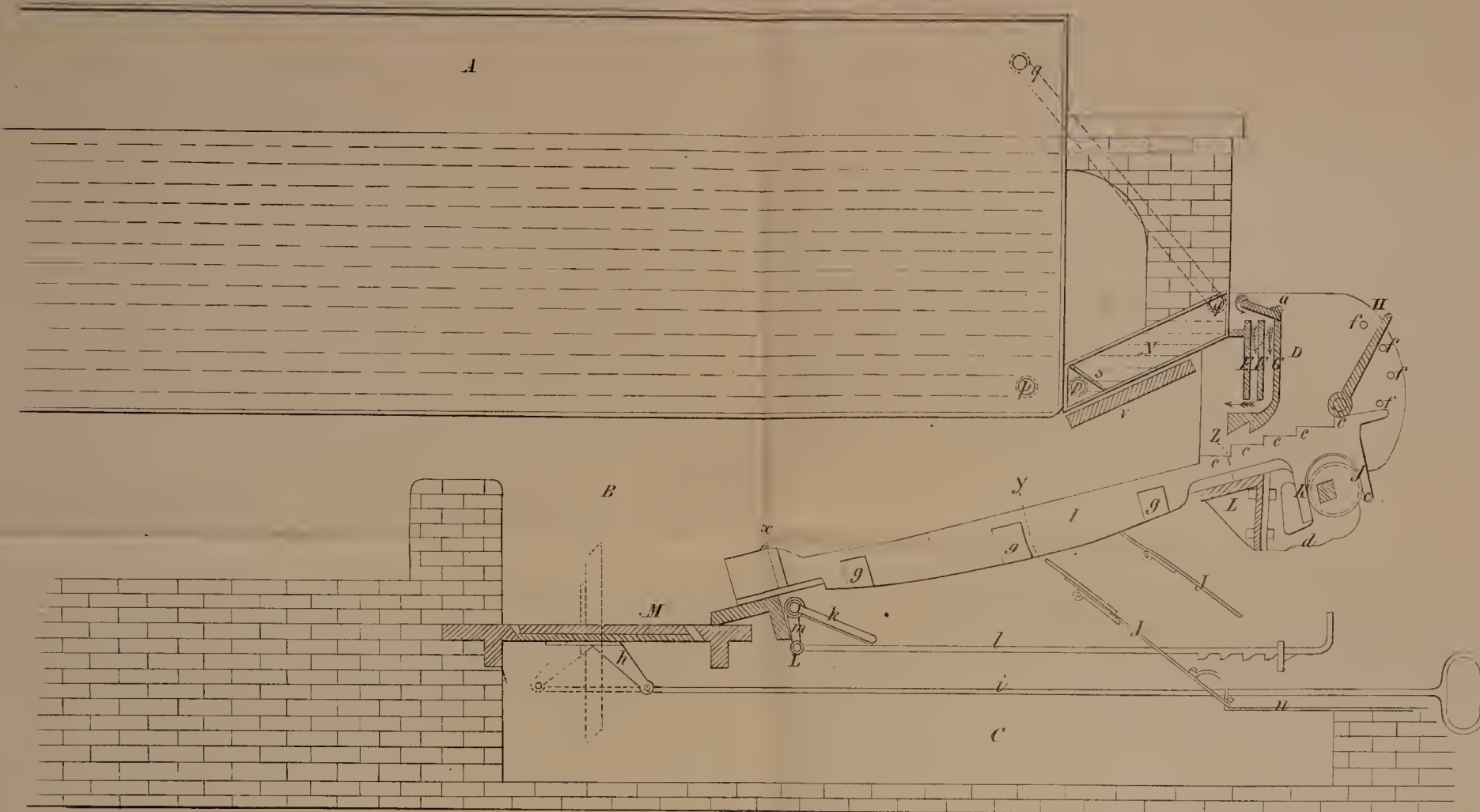


FIG. 4.

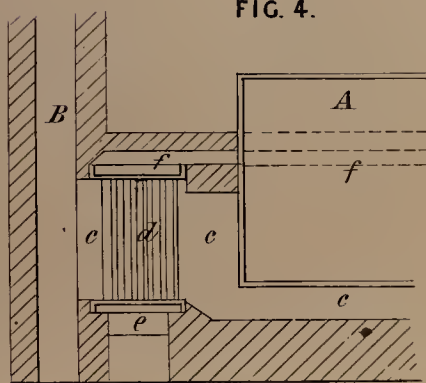


FIG. 5.

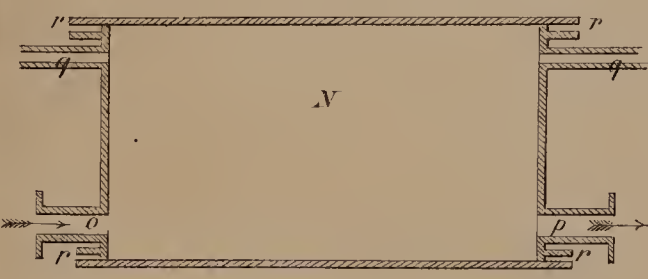


FIG. 2.

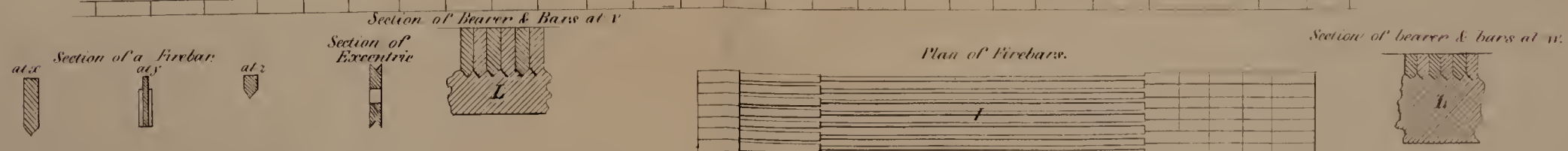
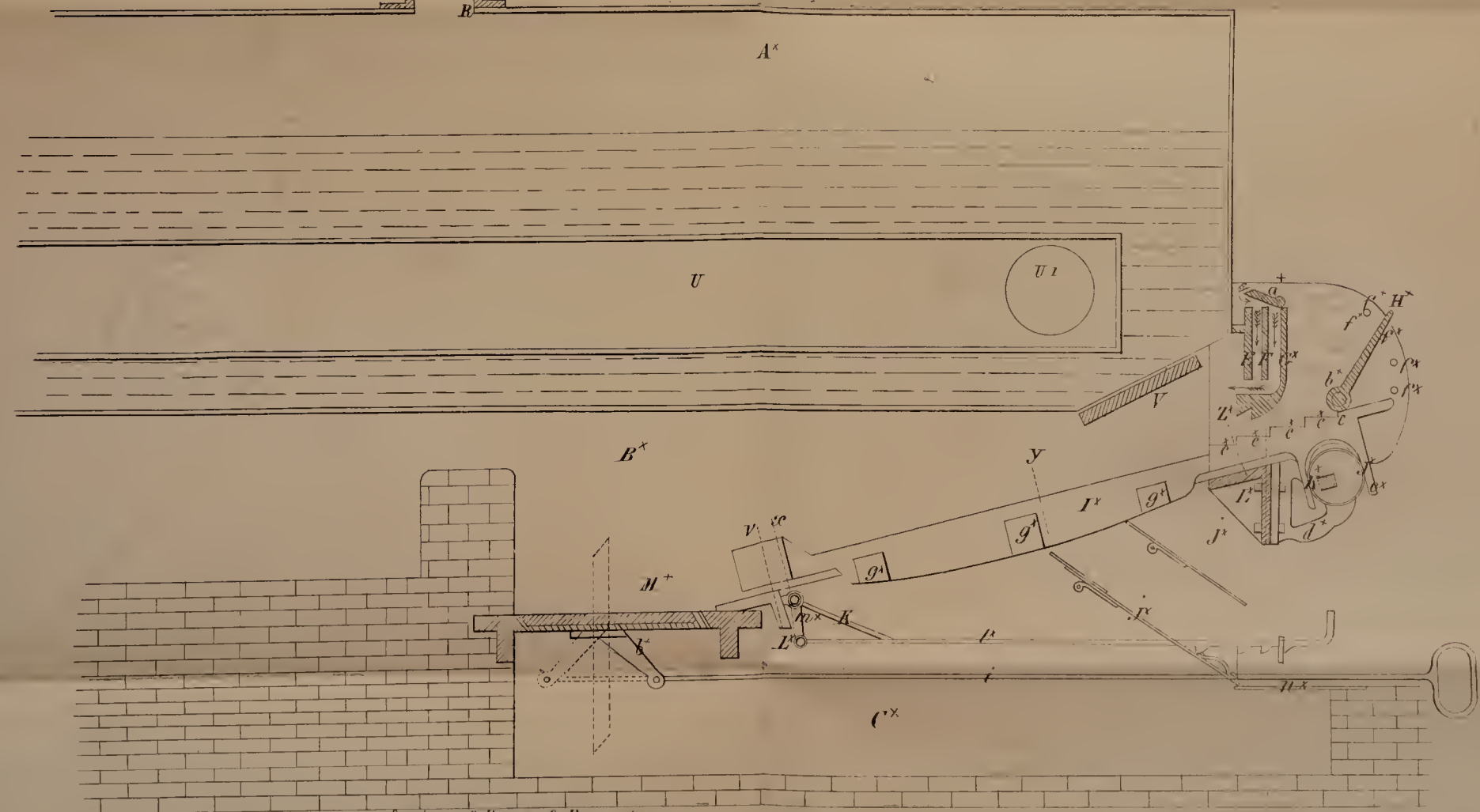
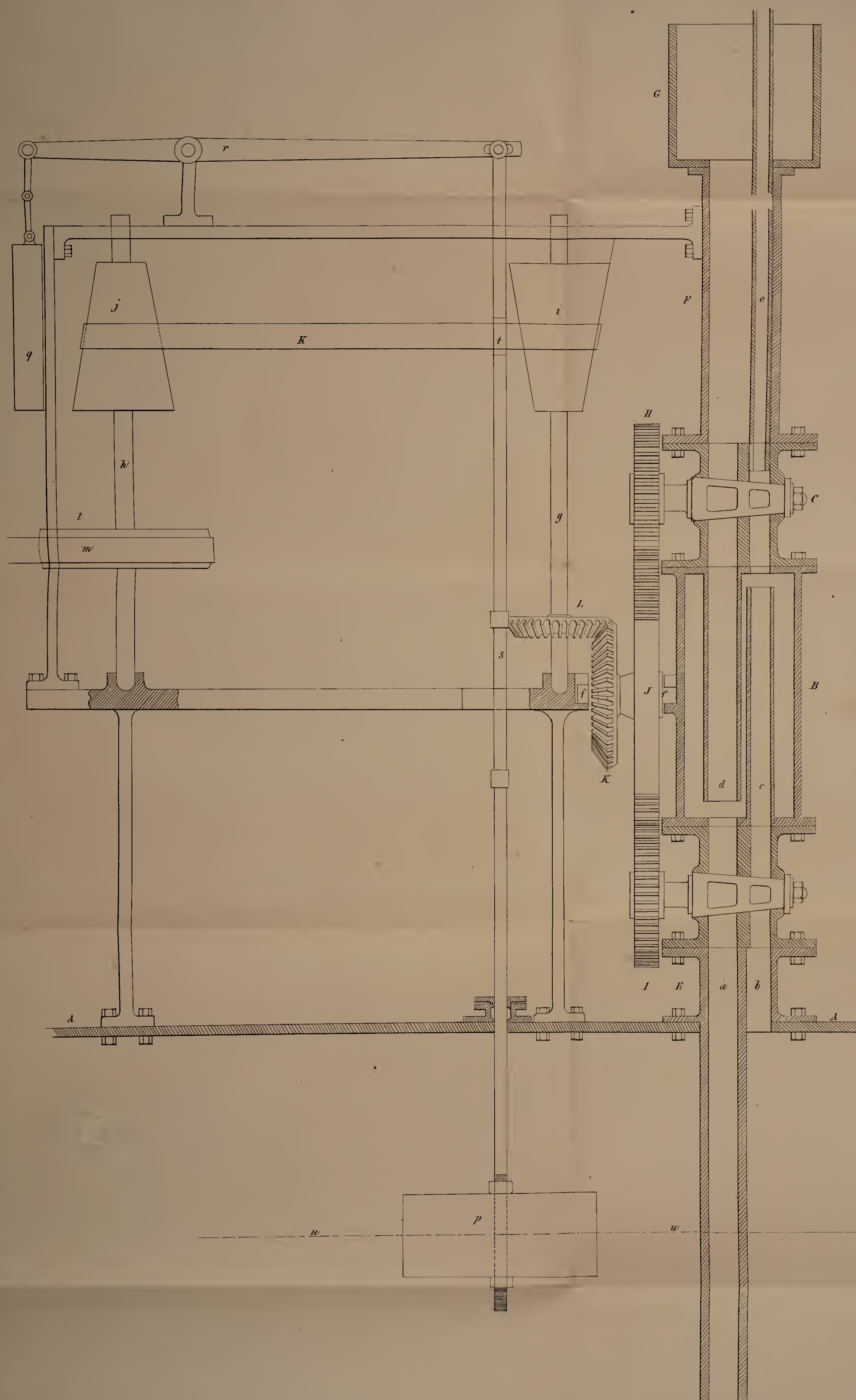


FIG. 2.



Malby & Sons, Lith

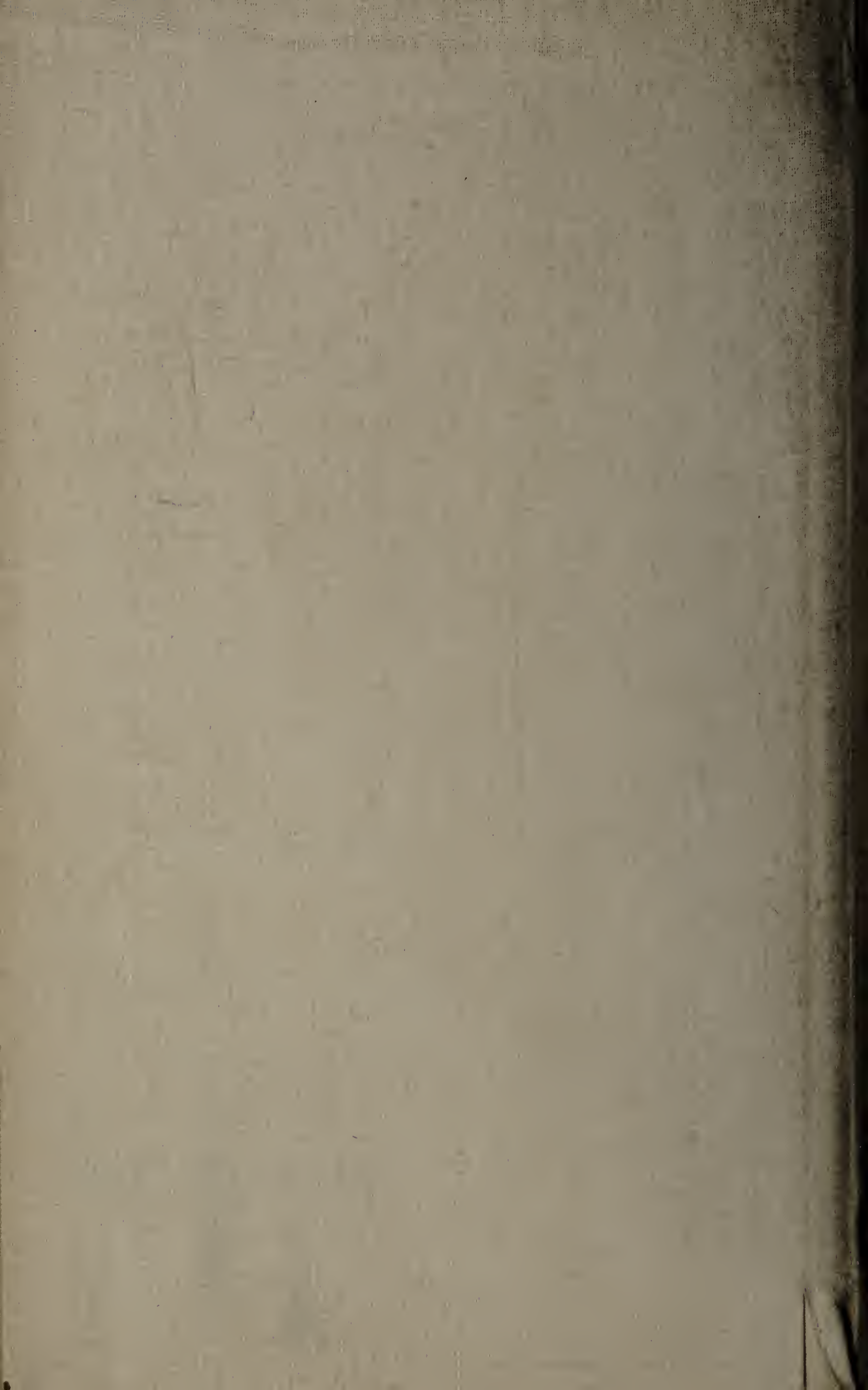


FIG. 1.

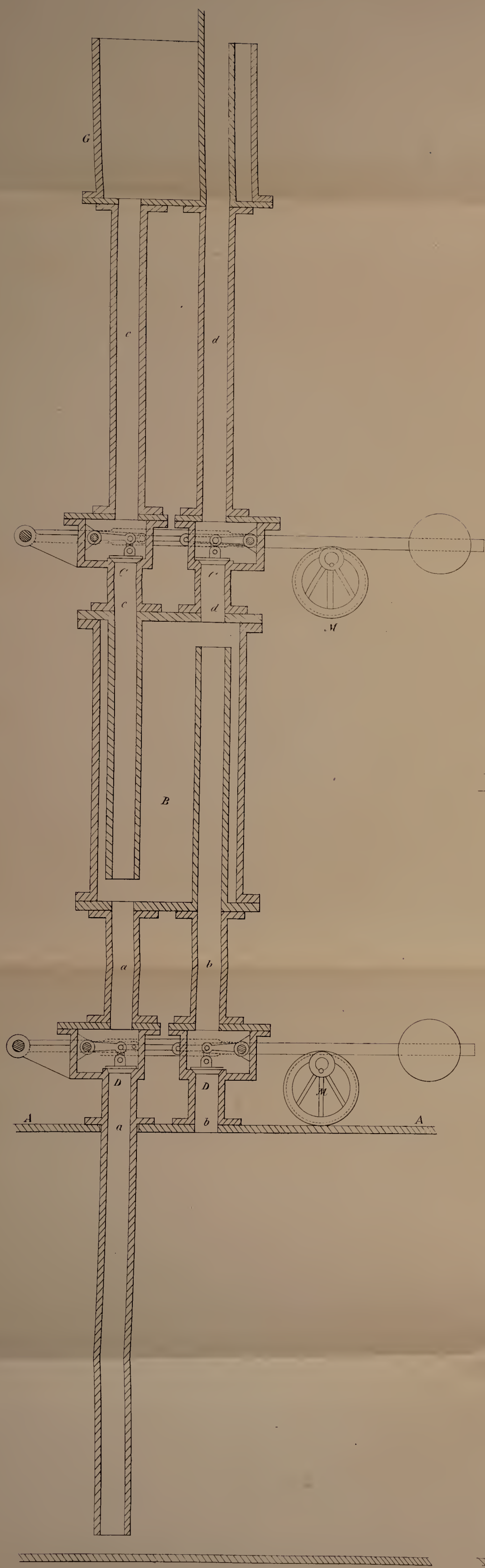
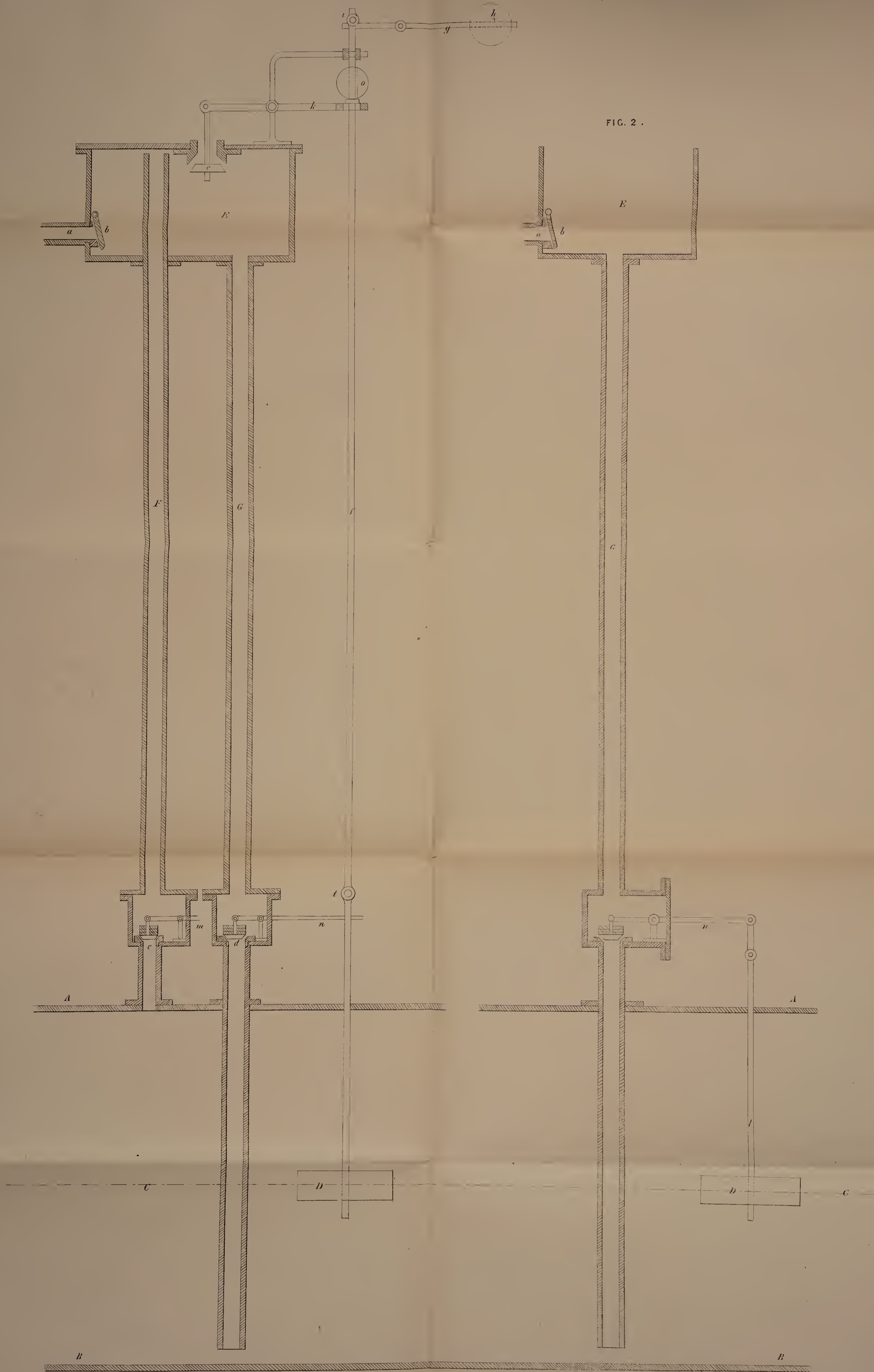


FIG. 2.



Hall's Improvements in Boilers, Furnaces, Flues, &c.

into the ash pit; this shelf lined with fire brick I claim, whether the axles on which it moves are placed at or near the middle or at the back end of it nearest to the furnace bridge.

My seventh claim is for spaces between the fire-bars narrower at the far
5 ends than they are in the middle of such bars for all furnaces that are supplied at the fronts with fuel, which is gradually moved from thence to the back or bridge of such furnaces by mechanical means.

My eighth claim is for the inclination of the fire-bars of about three or four inches, more or less, to the foot, from their fronts to their backs, instead of
10 being in a horizontal position, such inclination being for the purpose of facilitating the feeding of the furnace from one end to the other with fuel; but I limit this claim to furnaces having moveable bars or apparatus for supplying fuel to them, and I do not extend it to such as have stationary bars, and are not supplied by them with fuel by mechanical means from the front to the
15 bridge.

My ninth claim consists of indented bearing bars to carry the fire-bars, as shewn by L, L, and L^x, L^x, Figures 1 and 2, Sheet 1, and of bars formed so as to work in those indentations; also of indented excentrics with the fire-bar forks, shaped also so as to work in them, as shewn in the above two Figures
20 and Sheet.

My tenth claim consists of the three back hopper plates E, F, G, and E^x, F^x, G^x, Figures 1 and 2, Sheet 1, with two spaces between them for supplying air to the fronts of the furnaces, the front plates G and G^x having jaws at the bottom of them, and being moveable on an axle so as to be lifted from
25 its vertical position to a horizontal one, thereby enlarging the opening into the furnaces between the fire-bars and the two plates E, F, and E^x, F^x, to give easier access to the furnaces.

My eleventh claim is for heating the air previously to its entering furnaces, to consume the smoke by passing such air through a number of pipes placed in
30 the chimney or in a chamber leading thereto from the furnace; but I limit this claim to such furnaces as are supplied with fuel from their fronts to their backs by mechanical means, and do not extend it to furnaces supplied with fuel in the usual way by manual labour.

My claims under the head of "Improvements in Apparatus for Preventing
35 Explosions of Steam Boilers and other Accidents to which they are liable," are as follows:—

First, I claim the methods or apparatus herein-before described for supplying boilers with water by alternately filling a vessel with water and emptying it into them.

Hall's Improvements in Boilers, Furnaces, Flues, &c.

Second, I claim the methods or apparatus herein-before described for preventing water becoming too low in boilers when no apparatus for supplying them is at work.

Third, I claim the method or apparatus herein-before described of effecting the unerring action of all safety valves whatever by a rotatory or partially 5 rotatory motion and back again on their seats.

I would here remark that I do not confine myself to the precise details herein given, so long as the peculiar character of my Invention is retained.

In witness whereof, I, the said Samuel Hall, have hereunto set my hand and seal, this Nineteenth day of September, in the year of our Lord 10 One thousand eight hundred and forty-nine.

SAMUEL (L.S.) HALL.

CROSBY.

AND BE IT REMEMBERED, that on the Nineteenth day of September, in the year of our Lord 1849, the aforesaid Samuel Hall came before our said 15 Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and everything therein contained and specified in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

Enrolled the Nineteenth day of September, in the year of our Lord One 20 thousand eight hundred and forty-nine.

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